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A BIBLIOGRAPHY OF PUBLICATIONS BY THE INTERMOUNTAIN FOREST
AND RANGE EXPERIMENT STATION ON THE GENETICS AND BREEDING
OF FOREST TREES, 1921-1965

Compiled by Vendla K. Roberts

The articles listed in this bibliography are the results of forest genetics and tree breeding research done by staff members and cooperators of the Intermountain Forest and Range Experiment Station.

BAKER, F. S. 1921. Two races of aspen.
J. Forest. 19: 412-413.

In Utah, two races of aspen (Populus tremuloides) commonly appear at middle and higher elevations. They are distinguished by differences in leafing time, in time of leaf falling, in general color of bark and leaves, and in quality of form. As yet, cause of these differences is unaccounted for.

BARNES, BURTON V. 1964. Self- and cross-pollination of western white pine: a comparison of height growth of progeny. Intermountain Forest and Range Exp. Sta., U.S. Forest Serv. Res. Note INT-22, 3 pp.

Comparison of height growth of progeny from self- and cross-pollinated western white pine shows that seedlings from self-pollinated parents usually show slower growth after outplanting than seedlings from cross-pollinated parents.

BARNES, BURTON V., and R. T. BINGHAM. 1962. Juvenile performance of hybrids between western and eastern white pine. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Note 104, 7 pp., illus.

At three sites in northern Idaho, two Pinus monticola X P. strobus hybrid progenies were approximately twice as tall and markedly excelled corresponding P. monticola progenies (having the same female parents) in height growth at 8 years. At one site in western Montana none of the few P. monticola, P. strobus, and hybrid progenies performed satisfactorily.

BARNES, BURTON V., and R. T. BINGHAM. 1963. Cultural treatments stimulate growth of western white pine seedlings. Intermountain Forest and Range Exp. Sta., U.S. Forest Serv. Res. Note INT-3, 8 pp., illus.

Describes an experiment to determine effectiveness of cultural treatments (cultivating, fertilizing, and watering in all possible combinations) in stimulating growth rate and inducing strobilus formation. Strobilus production was negligible, but striking differences in total height and diameter growth were attributed to the treatments.

BARNES, BURTON V., and R. T. BINGHAM. 1963. Flower induction and stimulation in western white pine. Intermountain Forest and Range Exp. Sta., U.S. Forest Serv. Res. Pap. INT-2, 10 pp.

Describes four experiments designed to discover means of inducing strobilus formation in young seedlings and grafts of western white pine. Not one of the methods attempted was successful in markedly inducing or stimulating strobilus production.

BARNES, BURTON V., R. T. BINGHAM, and A. E. SQUILLACE. 1962. Selective fertilization in *Pinus monticola* Dougl. II. Results of additional tests. *Silvae Genetica* 11, Heft 4: 103-111, illus.

Tests were made to determine the extent of reproductive discrimination between competing self- and outcross-pollens of western white pine trees. Two seed trees were termed "completely self-fertile" and two trees were termed "partially self-fertile." However, most western white pine trees show a moderate to strong discrimination against self-pollen.

BINGHAM, R. T. 1956. Some preliminary results in testing seedling progenies from controlled pollinations among blister rust resistant western white pine. Third West. Int. Forest. Dis. Work Conf. Proc. 1955: 77-86.

Tests of F_1 progenies from 47 rust-free western white pine selections showed that rust resistance was heritable. A small percentage of the selections transmitted a

high degree of foliar resistance to their F_1 offspring, and about one-fourth to one-fifth of the selections were transmitting a useful degree of foliar resistance.

BINGHAM, R. T. 1959. Heritability and genetic improvement in log quality. Univ. Idaho Log Grading Conf. Proc., pp. 24-26.

A review of research results reveals the scarcity of concrete evidence as to genetic gain in characters affecting log quality. However, the small amount of evidence at hand indicates good likelihood for effecting genetic improvement of growth rate, stem form, branch angle, branch size, and spiral grain, all of which affect log quality.

BINGHAM, R. T. (Editor). 1960. An annotated directory to Canadian and foreign workers in forest genetics and related fields. *J. Forest.* 58: 602-618.

A cross-referenced directory giving names, addresses, and subject matter specialties of 744 Canadian and foreign workers in forest genetics.

BINGHAM, R. T. 1960. Progress in breeding blister rust resistant western white pine. Seventh West. Int. Forest Dis. Work Conf. Proc. 1959: 54-57.

Summarizes results to date of first generation breeding work and what these results mean in respect to production of resistant western white pine planting stock in the near future.

BINGHAM, R. T. 1961. The intra-species approach in breeding for disease resistance. Pp. 1691-1693. IN: Recent Advances in Botany, 1766 pp. Toronto: Univ. Toronto Press.

Suggests that with valuable local species the greatest early gains will come from intraspecies breeding. Breeding should be directed toward greater general adaptability in promising introduced species.

BINGHAM, R. T. 1963. New developments in breeding western white pine. 1. Breeding for blister rust resistance. Forest Genetics Workshop Proc., South. Forest Tree Improvement Comm. Sponsored Pub. 22: 69-70.

Recent developments under the long-range program for breeding blister rust resistant western white pine are reported. Establishment of seed orchards to produce 50-percent resistant F_2 seed by 1970 appears to be feasible.

BINGHAM, R. T. 1963. Problems and progress in improvement of rust resistance of North American trees. 12 pp. 1N: World Consultation on Forest Genetics and Tree Improvement Proc. 2. Rome: FAO.

Studies and experiments directed toward production of strains of pines and poplars in North America resistant to Melampsora, Peridermium harknessii, Cronartium fusiforme, and C. ribicola indicate that no foreseeable obstacle (genetic variation within rust pathogens included) precludes attainment of highly resistant types.

BINGHAM, R. T., J. W. HANOVER, H. J. HARTMAN, and Q. W. LARSON. 1963. Western white pine experimental seed orchard established. J. Forest. 61: 300-301, illus.

Management practices for western white pine seed orchards are being analyzed on a 17-acre orchard established in 1960 on the Kaniksu National Forest at Sandpoint, Idaho. Information gained here will apply to the operation of 100 acres of grafted seed orchards proposed for production of relatively resistant western white pine stock.

BINGHAM, R. T., and A. E. SQUILLACE. 1955. Self-compatibility and effects of self-fertility in western white pine. Forest Sci. 1(2): 121-129, illus.

Cone and seed yields, germinability, and seedling height following self-pollination of 28 trees were compared against corresponding values for cross-pollination. Considerable tree-to-tree variation in self-compatibility and self-fertility was found. "Self-ability" or yield of self-pollinated seedlings relative to yield of cross-pollinated seedlings also varied considerably, averaging about 50 percent for the 28 trees studied. Seedling height during the first, second, and third years averaged 11, 21, and 21 percent, respectively, below heights of cross-pollinated seedlings.

BINGHAM, R. T., and A. E. SQUILLACE. 1957. Phenology and other features of the flowering of pines, with special reference to Pinus monticola Dougl. U.S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Pap. 53, 26 pp., illus.

In western white pine the average date of first anthesis at high elevation was July 8, at low elevation June 27. Average period of pollen dissemination was $8\frac{1}{2}$ days, ovulate flower receptivity, $9\frac{1}{2}$ days. Flowering was delayed approximately 5 days per 1,000 feet increase in elevation, and 6 days per degree F. departure of May and June temperature below normal. Individual trees were found to be consistently early or late in time of onset of flowering, and the sequence of flowering between localities was firmly fixed.

BINGHAM, R. T., A. E. SQUILLACE, and J. W. DUFFIELD. 1953. Breeding blister-rust-resistant western white pine. J. Forest. 51: 163-168, illus.

Work on rust resistance in western white pine was started in the Inland Empire region in 1949. This article is a progress report covering work accomplished thus far and plans for future work.

BINGHAM, R. T., A. E. SQUILLACE, and R. F. PATTON. 1956. Vigor, disease resistance, and field performance in juvenile progenies of the hybrid Pinus monticola Dougl. X Pinus strobus L. Zeitschrift für Forstgenetik und Forstpflanzenzüchtung 5(4): 104-112, illus.

Juvenile performance of 16 different hybrid progenies from controlled pollinations between blister rust-resistant selections of eastern and western white pines is discussed in detail. Hybrids usually showed definite hybrid vigor and less resistance to rust than corresponding intraspecies crosses. The degree of hybrid vigor and rust resistance of a hybrid progeny seems to depend upon the superiority of the individual parents.

BINGHAM, R. T., A. E. SQUILLACE, and J. W. WRIGHT. 1960. Breeding blister rust resistant western white pine. II. First results of progeny tests including preliminary estimates of heritability and rate of improvement. Silvae Genetica 9, Heft 2:33-41, illus.

Describes and quantifies inheritance of blister rust resistance in controlled pollinated progenies of western white pine, extending the analyses to prediction of per-generation gain in resistance.

BINGHAM, R. T., A. E. SQUILLACE, and JONATHAN W. WRIGHT. 1961. Heritability of resistance in progenies from blister rust-resistant Pinus monticola selections. Pp. 1606-1612. IN: Recent Advances in Botany, 1766 pp. Toronto: Univ. Toronto Press.

Differences between types of mating and between individual single-cross progenies within resistant phenotype X resistant phenotype mating were highly significant. While average control progeny contained 5 percent survivors, the best wind-pollinated progeny of resistant phenotypes contained 19 percent survivors, and the best control-pollinated progeny of two resistant phenotypes contained 48 percent survivors, after

intense artificial inoculation of F_1 seedlings in tests since 1952.

CALLAHAM, R. Z. 1960. Selecting the proper seed source of ponderosa pine. Soc. Amer. Forest. Proc. 1959: 26-27.

Supplies factual evidence to support long-standing recommendations on guides for selecting proper seed sources. For best performance, seed should be collected within an elevational zone of 1,000 feet above or below the planting site, within 50 miles, and from average or better trees.

CALLAHAM, ROBERT Z. 1960. Experimental taxonomy--more than seed source studies. Abstr. Ninth Int. Bot. Cong. Proc. 1959, II: 57.

Stresses need for new methods of experimental taxonomy to gain an understanding of physiology, biochemistry, genetics, and comparative cytology and morphology in foresters' investigations of variation. New approaches, such as used in ponderosa pine studies, can lead quickly and efficiently to resolving patterns of variation.

CALLAHAM, ROBERT Z. 1960. Temperature and seed germination for races of ponderosa pine. Abstr. Ninth Int. Bot. Cong. Proc. 1959, II: 57-58.

Rates of germination were determined at 8°, 16°, 24°, and 36° for half-sib progenies from 20 sources. Significant regional and local differences in germinative energy and germinative capacity were detected at most temperatures.

CALLAHAM, ROBERT Z. 1962. Geographic variability in growth of forest trees. Ch. 20, pp. 311-325. IN: Tree Growth, 442 pp., illus., edited by Theodore T. Kozlowski. New York: The Ronald Press.

Elaborates the theme that tree growth, like all other plant characters, results from interaction of genes and environment

and that the genes, environment, and interaction are not the same for every individual of a species.

DUFFIELD, J. W., and R. T. BINGHAM. 1963. Forest genetics and its application by the small woodland owners. Pp. 286-288. IN: Woodland Handbook for the Pacific Northwest, 422 pp. Fed. Coop. Ext. Serv., Oregon State Univ., Corvallis, Ore.

Provenance, heritability, plus tree seed orchard and fertilization studies point the way toward practical steps that the small woodland manager may take in improving seed used for reforestation. It suggests that the manager develop his own "local" seed supply, that he insist that genetic identity of his seed and nursery stock be maintained, and that he give consideration to genetics in his timber harvesting practices.

FOREST GENETICS STEERING COMMITTEE. 1952. A guide for the selection of superior trees in the northern Rocky Mountains. U.S. Forest Serv., Northern Rocky Mountain Forest and Range Exp. Sta. Misc. Pub. 6, 7 pp.

This report lists general specifications for superior trees, tells where to select them, shows distinguishing traits of individual species, and presents a program for discussing and reporting "plus" trees.

HANOVER, JAMES W. 1962. Clonal variation in western white pine. I. Graftability. U.S. Forest Serv., Inter-mountain Forest and Range Exp. Sta. Res. Note 101, 4 pp., illus.

Discusses some reasons for success or failure in graftability of different clones of western white pine.

HANOVER, JAMES W. 1963. Comparative biochemistry and physiology of western white pine (Pinus monticola Dougl.) resistant and susceptible to infection by the blister rust fungus (Cronartium

ribicola Fischer). Ph. D. Thesis, Washington State Univ., 176 pp.

More than 100 organic compounds were compared in resistant and susceptible trees. Possible differences were found in levels of glucose, total amino acids, and one phenolic. These leads will be followed in further studies.

HANOVER, JAMES W. 1963. Geographic variation in ponderosa pine leader growth. Forest Sci. 9: 86-95, illus.

Growth of the short apices of 91 trees in a 45-year-old ponderosa pine provenance test was measured periodically with a transit. The 19 races in the test showed phenological, morphological, or physiological variation in six characteristics: date of beginning growth in the spring, date of ending growth, total seasonal elongation, duration of growth, length of dormant terminal bud, and rapidity of growth.

HANOVER, JAMES W. 1963. New developments in breeding western white pine. II. Biochemistry of rust resistance. Forest Genetics Workshop Proc., South. Forest Tree Improvement Comm. Sponsored Pub. 22: 76-78.

Biochemical analyses for free sugars, amino acids, protein hydrolysates, organic acids, chlorophyll, B-carotene, and phosphorylated compounds, and analyses for dry matter, pH, and ash have failed to show associations with blister rust resistance. Preliminary information indicates association of a phenolic compound with resistance, but much additional study will be required to verify the association.

HANOVER, JAMES W. 1965. Effect of the chemical mugaten ethyl methane-sulfonate on western white pine. Silvae Genetica 14, Heft 1: 23-26.

Describes materials and methods used in experimental chemical treatment of seeds from eight progenies produced by

controlled pollination. Reports results of treatment and analyzes significance of variance in plant characteristics due to this treatment.

HANOVER, JAMES W., and BURTON V. BARNES. 1963. Heritability of height growth in year-old western white pine. Forest Genetics Workshop Proc., South. Forest Tree Improvement Comm. Sponsored Pub. 22: 71-76.

This paper reports results of an experiment in which total height and epicotyl length of 1-year-old seedlings of western white pine were used for computing heritability based on a modified diallel cross. The results clearly demonstrated presence of a relatively high male-female interaction in height growth compared with variation due to additive gene action.

KEMPF, GERHARD. 1928. Non-indigenous western yellow pine plantations in northern Idaho. Northwest Sci. II(2): 54-58.

An unreplicated, 21-source ponderosa pine provenance test, with 100 trees per source, established 11 to 16 years previously at the Priest River Experimental Forest in northern Idaho (2,400 ft.) is described. Under a numerical indexing system considering each of four factors (survival, height growth, tree vigor, and frost resistance), five of the seven local sources, which were located on west slopes of the Northern Rocky Mountains, outperformed all others.

SMITH, EDWARD W., III, ELBERT CLEVELAND, and DONALD W. LYNCH. 1956. A guide for finding superior ponderosa pine trees and stands in southwestern Idaho. South. Idaho Forest. Assoc., Inc., 8 pp+.

Defines for laymen certain genetics terms; gives instructions for selecting and reporting "plus" ponderosa pine trees.

SQUILLACE, A. E. 1952. Opportunities for forest genetics research in the northern Rocky Mountain region. Mont. Acad. Sci. Proc. 11: 3-7.

This paper describes experimental projects in forest genetics research that were active at the time of writing. Major current projects were: (1) a study of origins of ponderosa pine seed; (2) experimental breeding of blister rust resistant species of western white pine; (3) studies of special methods of propagation; and (4) testing of several pine hybrids. Proposes additional desirable projects for research.

SQUILLACE, A. E. 1957. Variations in cone properties, seed yield, and seed weight in western white pine when pollination is controlled. Mont. State Univ., School of Forest. Bull. 5, 16 pp., illus.

Seeds borne on shoots in the upper and outer crown and on the south and west sides of individual trees tended to be heavier than those in opposing portions of the crown. Cones borne on the more fruitful shoots tended to be longer and contained heavier seeds than those on the less fruitful shoots. Average weight of seeds in individual cones was found to be directly related to cone length and scale size and inversely related to seed yield. Longer cones usually yielded more seed but yield was also affected by pollen parent. An apparent effect of pollen parent upon the shape of cone scales was also found.

SQUILLACE, A. E., and R. T. BINGHAM.
1954. Breeding for improved growth rate and timber quality in western white pine. J. Forest. 52: 656-661, illus.

Techniques and early results of intra-species breeding for faster growth rates and better quality in western white pine. Progeny seedlings produced through controlled pollinations among selected trees varied considerably in total height and significantly, though not strongly, reflected the growth rate of their respective parents. Average annual height growth during the last 10 years appeared better for studying heritability than average annual height growth during the whole life of the parent trees. A technique for measuring phenotypic traits in relatively open-grown, young western white pine trees was devised, which proved practical.

SQUILLACE, A. E., and R. T. BINGHAM.
1954. Forest genetics research in the northern Rocky Mountain region. J. Forest. 52: 691-692.

Brief descriptions of forest genetics research projects in the northern Rocky Mountain region and some tentative recommendations for the conduct of future research.

SQUILLACE, A. E., and R. T. BINGHAM.
1958. Localized ecotypic variation in western white pine. Forest Sci. 4(1): 20-34, illus.

Study of juvenile growth rates, apparent seed osmotic pressures, and foliage dry matter content of both controlled- and wind-pollinated seed and seedling progenies of Pinus monticola Dougl. trees growing on radically different sites indicated existence of ecotypes of very local nature.

SQUILLACE, A. E., and R. T. BINGHAM.
1958. Selective fertilization in Pinus monticola Dougl. I. Preliminary results. Silvae Genetica 7, Heft 6: 188-196, illus.

Describes the preliminary results, based on 1-year-old progenies, from three tests to determine the selective fertilization effects of competing pollen in Pinus monticola Dougl.; makes recommendations for future study.

SQUILLACE, A. E., and ROY R. SILEN.
1962. Racial variation in ponderosa pine. Forest Sci. Monogr. 2, 27 pp., illus.

Data from two ponderosa pine provenance studies conducted in northern Idaho and in Oregon and Washington were analyzed in detail. Results verify apparent differences in growth rate found earlier and correlate these differences with various geographic and climatic factors of the seed source localities.

WEIDMAN, R. H. 1925. Ten years' trial of some introduced species at Priest River Experiment Station. U.S. Forest Serv., Northern Rocky Mountain Forest and Range Exp. Sta. Appl. Forest. Notes 56, 3 pp.

European larch, Norway spruce, Norway (red) pine, Scotch pine, Austrian pine, and eastern white pine were planted on a dry site and on a comparatively moist site. From results after 10 years, only Norway spruce and Scotch pine appeared worthy of additional trials in northern Idaho.

WEIDMAN, R. H. 1939. Evidences of racial influence in a 25-year test of ponderosa pine. J. Agr. Res. 59(12): 855-888, illus.

A 25-year study of ponderosa pine growth from seed collected in 20 localities in the western United States showed that several characteristics (viz., number of needles per fascicle, length of needles, general appearance of foliage, and rate of growth) corresponded to differences among trees in the parent localities. It was concluded that these characteristics are strongly heritable in ponderosa pine and that a tree's growth rate and hardiness should be investigated (along with climatic characteristics of the locality where it grows) before seed is used for reforestation.

WRIGHT, JONATHAN W., R. T. BINGHAM, and K. W. DORMAN. 1958. Genetic variation within geographic ecotypes of forest trees and its role in tree improvement. J. Forest. 56: 803-808.

A review of published works on intra-specific and interracial variation in forest tree species and a discussion of the possibility for utilizing this variation in forest tree improvement.

FOREST SERVICE CREED

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